Improved Thermophotovoltaic Energy Conversion with 3-D Tungsten Photonic Crystal

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Recent advances in thermophotovoltaic (TPV) energy conversion efficiencies to greater than 20% has increased interest in investigating the use of TPV in a wider spectrum of applications. One of the issues associated with using TPV is the high hot-side temperatures (> 1000K) necessary to obtain conversion efficiencies greater than 20%. The elevated temperature limits the available materials that can be used as the hot-side emitter to either ceramics or refractory alloys which emit photons with a Planckian distribution. For semiconductor materials of interest for TPV energy conversion the ratio of convertible light to nonconvertible light is 25% for greybody emitters. Therefore, in order to increase the conversion efficiency, very complex cold-side front surface filter technology is utilized.

In order to relax the requirements imposed on the front surface filter, 3-D tungsten photonic crystals (PC) are being investigated for hot-side emitters in TPV energy conversion. The PC increases the emission in the convertible wavelength range (over bulk tungsten) and suppresses the emission in the non-convertible wavelength range, which results in a greater than 10% improvement in conversion efficiency. Recent efforts utilizing tungsten PC for mWe power conversion will be reported.

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